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DIAGNOSTIC VALUE OF ELASTOGRAPHY IN NODULAR THYROID DISEASE WITH ADIPOSITY ASSOCIATION

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Abstract

Background/aim: Nodular thyroid disease is widely encountered in the population. It is almost benign and the rate of prevalence differs according to the population, which is gradually increasing, although most of the thyroid nodules are benign. The prevalence of malignancy is 5%-15% and 15%-30% are classified as indeterminate or suspicious for malignancy. A thyroid ultrasonography examination is recommended for the patient had thyroid nodules according to the guidelines of the American Thyroid Association (ATA). Elastography is a recent method used in evaluating thyroid nodules by comparing tissue elasticity. There is still a controversial association between adiposity and thyroid nodules.

Aims of this study; highlight the value of elastography to evaluate nodular thyroid disease and find its association with adiposity.

Subject and Methods: This cross-section study was done on 170 patients (65 males and 105 females); they were referred to thyroid elastography examination, from internal medicine, endocrinology, surgery and oncology departments. Anthropometric measurements and imaging of the thyroid nodules were done according to the American College of Radiology (ACR) and Thyroid Imaging Reporting and Data System (TI-RADS). The patients were classified into three groups according to body mass index (BMI); a normal weight group had a BMI $\leq$ 24.9 kg/m^2 (n = 60), an overweight group had a BMI of (25-29.9 kg/m^2) (n = 50) and an obese group had a BMI $\geq$ 30 kg/m^2 (n = 60).

Results: The data of this study revealed that qualitative elastography grades could differentiate benign thyroid nodules from malignant; elastography with higher grades was detected within malignant thyroid nodules. Moreover, a Strain's ratio (SR) cutoff value is >2.3 which could differentiate a malignant nodule from a benign one with a 93 % sensitivity, 81.4 % specificity and

92.4% accuracy. As a greater proportion of patients (64.7%) with thyroid nodules had a BMI of more than 25 kg/m^2. The high elastography grade (malignant nodule) was significantly associated with a higher BMI and greater waist circumference (WC). Although the optimal BMI cutoff value was (≥30 kg/m^2) for both sexes and the WC cutoff value in males was 105.6 cm with a sensitivity of 69.1% & specificity of 71% & in females was 95.7 cm with a sensitivity of 72.1% and specificity of 58.3%.
Conclusion: The elastography examination is an accurate method to assess thyroid nodules. There is a high association between adiposity and thyroid nodules.

Keywords: Elastography, Thyroid, Nodules and Adiposity.

INTRODUCTION:

Nodular thyroid disease is widely encountered in the population, it is usually benign. Its prevalence rate is gradually increasing and differs according to the population & the diagnostic method used. Thyroid nodules are found in 33% of adults, their age range (18 - 65 years), moreover 50% over 65 years old. The benign thyroid nodules represent the majority of total nodules. The prevalence of malignant nodules is between 5% & 15%, while the indeterminate or nodules with malignancy suspicious represent (15%-30%) [1]. Most nodules are asymptomatic, benign and don't require surgical intervention, so an accurate diagnosis is important for proper therapeutic management. As well early diagnosis of nodules with malignant criteria is particularly important for therapeutic planning [2].
A thyroid ultrasonography (US) examination is recommended for the patient had thyroid nodules according to guidelines of the American Thyroid Association (ATA) [3]. Thyroid US being easily accessible, non-invasive and cost-effective, it is the clue examination of thyroid nodules for proper management [4]. Elastography ultrasonography is the best imaging modality for the evaluation of thyroid nodules using tissue elasticity [5] and Strain Ratio (SR) or shear-wave elastography (SWE) to assess nodule consistency that could differentiate thyroid nodules (malignant or benign), instead of Fine Needle Aspiration (FNAC) for accurate diagnosis [6].
Several risk factors of nodular thyroid disease; gender, iodine deficiency, age, obesity and previous radiation exposure to head & neck [7-9]. Adiposity evaluation is traditionally based on the body mass index (BMI), other parameters were used to assess adiposity; waist & hip circumferences (WC& HC) and waist-hip ratio (WHR), to distinguish between general and central adiposity. The objectives of this study are to highlight the value of elastography in evaluating nodular thyroid disease and find its association with adiposity.

MATERIALS AND METHODS:

Study Design

This was a cross-sectional study, it was approved by the research ethics committee at the Faculty of Medicine, Helwan University before the study commencement [No: 149]. The study followed the Declaration of Helsinki guidelines on the conduct of human research. A written informed consent was designed by each patient. The study procedure was conducted at the radiology center, Cairo, Egypt.

Recruitment

A convenient sample of one hundred and seventy Egyptian patients (65 males and 105 females) were referred from the internal medicine, endocrinology, surgery and oncology departments. Informed consent was obtained from each patient after explaining the aims and benefits of this study, informing them about the confidentiality of obtained information and their right to withdraw at any time.

The inclusion and exclusion criteria:
The participants' age ranged from 30 to 65 years old, including both sexes. Patients had thyroid nodules that met the TI-RADS templet requirements, with adequate adjacent normal thyroid tissue. The nodule size was > 5 mm and it was solid with no or tiny cystic area. The participants were excluded if they had nodules near to vessel (common carotid artery), large nodules which occupied most of the lobe, nodules with large cystic changes or with calcifications (eggshell, or extensive intra-lesional), isthmic nodules and thyroiditis.

Outcome measures
I.Clinical assessment and Anthropometric parameters:
Clinical examination to identify the location, displacement characterization of thyroid lesion and identify related lymph nodes, then a body weight and a body height, waist & hip circumferences were taken following the International Biological Program recommendations [10]. Weight was taken using the Seca Scale balance, while the height was assessed by the Holtain anthropometer. Additionally, the waist circumference (WC) was measured by a tape positioned horizontally just above the iliac crest and under the umbilicus, although the hip circumference (HC) was measured by a tape at the largest buttocks circumference. Then BMI was calculated by; dividing the weight by the height squared (Kg/m^2) and WHR was calculated.

II.US examination and interpretation:
The ultrasonographic examination was done using PHILIPS, USA, using high-frequency probe (5-12 MHz), with elastography software. The patient was done in the supine position with a slightly neck extension over a pillow under the shoulders to avoid over-stretching neck muscles. The patient was asked to avoid swallowing during an assessment to minimize the thyroid gland movement. The thyroid gland was assessed in two views (longitudinal and transverse) and images were taken for each thyroid nodule, with specific evaluation regarding composition, echogenicity, shape, margin and presence of echogenic foci.

Imaging interpretation of the nodules was done according to the American College of Radiology (ACR). Thyroid Imaging Reporting and Data System (TI-RADS), as follows:
One feature selected from each:
- **Composition:** Cystic or almost completely cystic (0 points), Spongiform (0 points), Mixed solid and cystic (1 point) and Solid (2 points).
- **Echogenicity**: Anechoic (0 points), Hyper or iso-echoic (1 point), Hypoechoic (2 points) and markedly hypoechoic (3 points).
- **Shape:** Wider than tall (0 points) and Taller than wide (3 points).
- **Margin**: Smooth (0 points), Ill-defined (0 points), Lobulated or irregular (2 points) and Extra-thyroid extension (3 points).
- **Presence of echogenic foci**: None (0 point), Large comet-tai artifacts (0 points), Macro-calcifications (1 point), Peripheral rim of calcifications (2 points) and Punctate echogenic foci (3 points).

Points from all TI-RADS categories were added to determine TI-RADS Level as follows:
- TR 1: Benign – Score of 0 point.
- TR 2: Not suspicious – Score of 2 points.
- TR 3: Mildly suspicious –Score of 3 points.
- TR 4: Moderately suspicious –Score of 4 to 6 points.
- TR 5: Highly suspicious – score of 7 points or more.

Certain features of thyroid nodules on ultrasonography could predict malignant nodules. These criteria include: taller than wider, hypo-echogenicity, irregular margins, predominantly solid composition, absence of a hallo, presence of microcalcifications and intra-nodular vascularization at Doppler assessment.

III.Elastography examination and interpretation:

The elastography technique was performed using the same probe with split screen technology and activating the elastography function. Gentle sustained manual compression using a free hand was applied on the neck. The region of interest (ROI) draws on the lesion and then compares it with normal thyroid tissue. According to the manufacturer, the hardest structures and the most deformed soft tissues were displayed in different colours.

Strain elastography can assess elasticity by colours within the nodules and visually score according to the 4-5 scale scoring system (elasticity score). As well regions of interest (ROI) are specified at the target region (nodule) and adjacent normal thyroid tissue. The elastogram was represented as a colour-coded image; (Blue: represents hard stiff tissue, Red: represents soft tissue and Green: represents an intermediate level of stiffness). Also, it was interpreted according to Asteria's scoring system as follows: (score 1: elasticity is shown in the whole nodule, score 2: most of the nodule shows elasticity, score 3: most of the nodule is hard and score 4: all the nodule is hard). Another interpretation according to Rago's scoring system as follows: (score 1: the nodule is all elastic, score 2: the nodule is mostly elastic, score 3: the nodule is only elastic at the periphery, score 4: the nodule is entirely rigid and score 5: the nodule is entirely rigid and the surrounding tissue is rigid).

Then, semi-quantitative analysis was done based on strain Ratio (SR); two regions of interest (ROIs) were manually drawn at the nodule and at a normal thyroid as a reference, then SR was calculated by dividing the elasticity index of both. The patients were referred to FNAC if they diagnosed TI-RADS 4 – 5 and score 3 - 4 by Elastography.

Statistical Analysis

Data was analyzed using the Statistical Package for Social Sciences (SPSS/Windows Version 25, IBM Corporation); parametric data were expressed as mean ± standard deviations (SD), while the non-parametric data were expressed as a frequency distribution. Pearson´s correlation and the chi-square tests were used to examine the association and correlation between variables. Also, ROC curve and Odd's ratio were done. ($P < 0.05$) revealed a statistical significance.

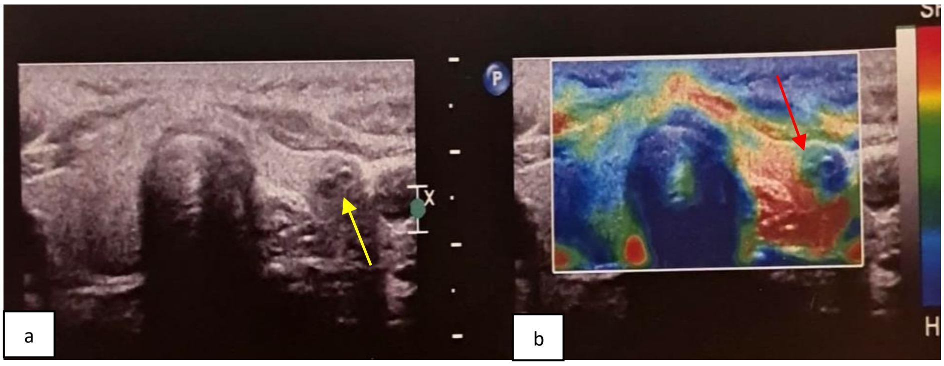

Fig. 1: A 46 years man, has thyroid nodule, was referred for elastography; (**a**) a B-mode transverse sonographic examination image showed a left hypoechoic rounded thyroid nodule with cystic changes inside, measuring about 12 X 10 mm (yellow arrow) and **(b)** colored transverse elastography image, showed mixed green and blue colour with predominate of the green colour (red arrow), denoting soft consistency of the nodule with low strain ratio (SR) 0.6, benign nodule.

Results

The present study included one hundred and seventy Egyptian patients (65 males and 105 females); their age (36-59 years, mean 40.1 years ± 4.2 SD) for males, (32-54 years, mean 38.3 years ± 5.6 SD) for females and 37.6% (64 patients) were aged ≥45 years. Most patients were women (61.8 %).

Their weight range (72–118 kg, mean 84.3 ± 6.4 kg SD & 64–128 kg, mean 89.8 ± 8.3 kg SD) and height (157–170 cm, mean 162.1 ± 5.1 cm SD & 148–164 cm, mean 154.2 ± 4.2 cm SD), for males and females respectively. They were classified according to BMI into three groups; normal weight (n = 60) (28 males & 32 females), overweight (n = 50) (21 males & 29 females) and obese (n = 60) (16 males & 44 females). Their WC range (82-121 cm, mean 98.1±12.7 cm SD) & (79-118 cm, mean 88.1 ± 9.4 cm SD), HC (80-128 cm, mean 106.3 ±12.4 cm SD) & (86-132 cm, mean121±9.7 cm SD) and WHR (0.67-1.14, mean 0.89 ± 0.4 SD) & (0.87-1.23, mean 0.92 ± 0.6 SD) for males and females respectively. There 64.7% of subjects had BMI ≥ 25 kg/m^2 (overweight and obese) **(Table 1)**.

Regarding anthropometric parameters, overweight and obesity were more frequently noted in female patients. However, there was insignificant differences were detected in age, weight, height and mean BMI between both sexes. Males had significantly higher WC than females, while females had significantly higher HC than males.

Regarding thyroid nodule location at different sexes, there was no statistically significant difference detected. The most common location is detected at the left lobe in female patients (39%), followed by the right lobe in male patients (36%), then both lobes & left lobe in males' patients (32%), while the right lobe represented the least frequency in females' patients (30%) **(Fig.2)**.

Sonography characteristics of thyroid nodules using B-mode proved that there was a statistically significant difference detected regarding solid isoechoic or heterogeneous nodules, which had taller than wider shapes between both sexes; as females had a significant higher frequency of suspicious malignant nodules than males, although most of the nodule had regular border (55.9%) and only (20.5 %) of patients had cervical lymph nodes **(Table 2)**.

Table 1: Anthropometric parameters in different sex

	Males	**Females**	**P-value**
	No. (65) (38.2%)	**No. (105) 61.8%**	
Age (mean years ± SD)	40.1 ± 4.2	38.3 ± 5.6	0.24
▪ **<45 years** No.102 (60%) (No. & %)	38 (22.4%)	64 (37.6%)	0.06
▪ **≥ 45 years** No.68 (40%) (No. & %)	27 (15.8%)	41 (24.2%)	0.35
Weight (mean ± SD)	84.3 ± 6.4 kg	89.8 ± 8.3 kg	0.63
Height (mean ± SD)	162.1 ± 5.1cm	154.2 ± 4.2 cm	0.47
BMI (mean ± SD)	34.4 ± 3.8	35.2 ± 5.1	0.15
- **Normal-weight** No. 60 (No. & %)	28 (16.5%)	32 (18.8%)	0.43
- **Overweight** No. 50 (No. & %)	21 (12.3%)	29 (17.1%)*	0.05
- **Obese** No. 60 (No. & %)	16 (9.4%)	44 (25.9%) **	0.01
Waist Circumference (WC) (mean ± SD)	98.1 ± 12.7cm	88.1±9.4cm **	0.01
Hip Circumference (HC) (mean ± SD)	106.3 ±12.4 cm	121 ± 9.7 cm*	0.05
WHR (mean ± SD)	0.89 ± 0.4	0.92 ± 0.6	0.15

* P ≤ 0.05 Significant and ** P ≤ 0.01 Significant.

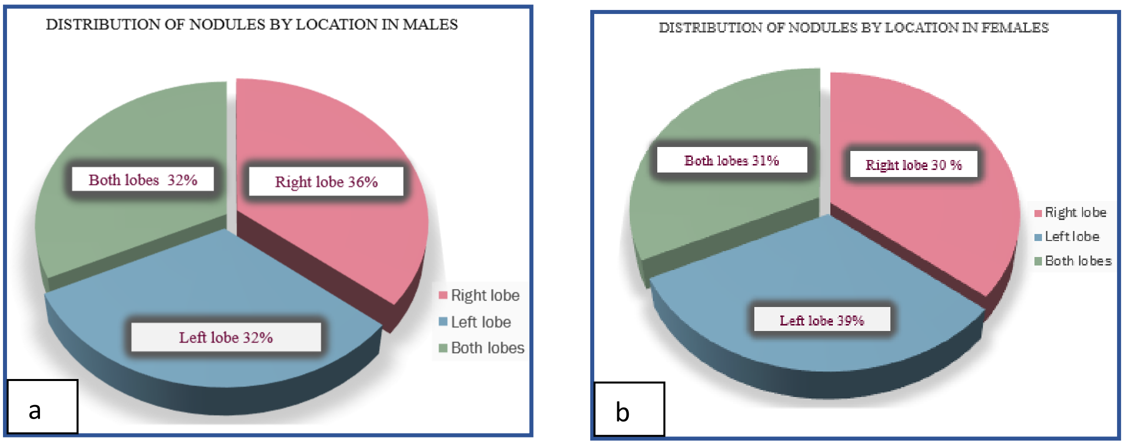

Fig. 2: Distribution of nodules in thyroid lobes at both sexes; (a) In males and (b) In females.

The distribution of thyroid nodule TI-RADS classification at both sexes to differentiate benign and malignant nodules was; (TI-RADS 1 & 2) benign lesions, while (TI-RADS 3) denoting mild suspicious and (TI-RADS 4 & 5) malignant lesions. The most frequent lesions were seen at both sexes within (TI-RADS 3) (43.1% and 49%) for females and males respectively, followed by (TI-RADS 2) (31% & 29.3%), then (TI-RADS 4 & 5) (25.9% & 21.7%) for females and males respectively. Although the distribution of thyroid nodules elastography score at both sexes was done; benign lesion (E1 & E2), mild suspicious (E3) and malignant lesion (E 4). The most frequent lesions were seen at (E 2) (50% & 49%) for females and males respectively, followed by (E3) (32% & 33%) for females and males respectively. There was (11% and 12 %) recorded at (E4) and (7% & 6%) were diagnosed at (E1) for females and males respectively. Strain ratios of all nodules were measured; the malignant thyroid nodules had a significantly increased SR compared with that of benign nodules. The strain ratio's (SR) mean value for benign lesions was (0.9 ± 0.6) and that for malignant lesions was (2.1±0.8). Moreover, ROC curve analysis was done and the area under ROC curve (AUC) for TI-RADS and elastography score to detect the cutoff point of a malignant thyroid nodule, TI-RADS 4 and E3 (p-value 0.001) for each. The strain ratio (SR) cut-off value of the malignant lesion was 2.3; with 93 % & 81.4 % sensitivity & specificity respectively and 92.4% accuracy. **(Fig. 3)**.

Table 2: Sonography characteristics of thyroid lesion frequency in both sexes

		Male	Female	P-value
		No. 65 (38.2%)	**No. 105 (61.8%)**	
Composition (No. & %)				
Solid	100 (58.9%)	37 (21.8 %)	63 (37.1 %) **	0.00
Cystic	30 (17.6%)	12 (7.0 %)	18 (10.6 %)	0.35
Mixed	40 (23.5%)	16 (9.4 %)	24 (14.1 %)	0.15
Echogenicity (No. & %)				
Hypoechoic	80 (47%)	36 (21.2%)	44 (25.8 %)	0.65
Isoechoic	35 (20.5%)	10 (5.8 %)	25 (14.7%) *	0.05
Heterogenous	55 (32.5%)	19 (11.2 %)	36 (21.3%) *	0.05
Shape (No. & %)				
Wider than taller	100 (58.9%)	60 (35.3%)	40 (23.6%)	0.32
Taller than wider	70 (41.1%)	5 (2.9 %)	65 (38.2%) **	0.01
Margin (No. & %)				
Regular	95 (55.9%)	30 (17.7%)	65 (38.2%) *	0.04
Irregular	75 (44.1 %)	35 (20.5%)	40 (23.6%)	0.15
Presence of echogenic foci (No. & %)				
Macro-calcification	42 (24.7%)	23 (13.5%)	19 (11.2%)	0.43
Micro-calcification	29 (17%)	15 (8.8%)	14 (8.2%)	0.53
Cervical lymph nodes (No. & %)				
Yes	35 (20.5 %)	11 (6.4 %)	24 (14.1%) *	0.05
No.	135 (79.5 %)	54 (31.8%)	81 (47.7%) *	0.03

* P ≤ 0.05 Significant and ** P ≤ 0.01 Significant.

ROC Curve

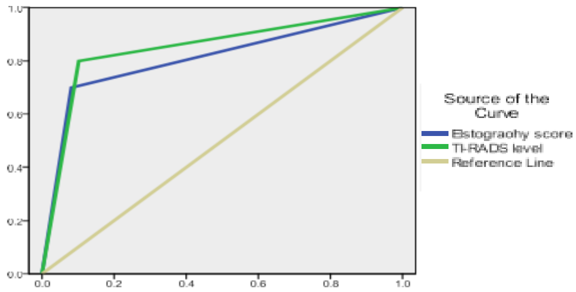

Fig. 3: ROC curve of TI-RADS and elastography score for thyroid nodule; when cutoff point 4 and E3 respectively (p value 0.001) for each.

Regarding adiposity and its association with thyroid nodules (benign or malignant) by elastography; 28 male patients had benign nodules and 37 (which represent 56.9% of total male patients) were diagnosed with malignant nodules. While 61 female patients had benign nodules and 44 (which represent 42.3% of total female patients) had malignant nodules. There was a statistically significant association between malignant thyroid nodules and increased BMI (obese, which was more frequent) and increased WC at both sexes. Additionally overweight was also more frequent with malignant thyroid nodules in male patients. However no statistical association between HC and WHR in both sexes, as well as male patients with normal weight. While the normal -weight female patients had a high statistical association with benign thyroid nodules **(Tables 3 and 4)**.

Also, using the area under the ROC curve of BMI and WC (for general and central adiposity) to predict malignant thyroid nodule risk. In males, the optimal BMI cutoff value was (≥30 kg/m^2) and the WC cutoff value was 105.6 cm (sensitivity 84.3% and specificity 82.1%) & (sensitivity 69.1% & specificity 71%) respectively. While, in females, the same cutoff BMI value (≥30 kg/m^2) and WC cutoff was 95.7 cm (sensitivity 82.8% and specificity 81.5%) & (sensitivity 72.1%, specificity 58.3%).

Table 3: Association between thyroid nodules nature by elastography and adiposity in males

	Elastography of Thyroid Nodules		
	Benign No. 28 (16.5%)	**Malignant No. 37 (21.7%)**	**P-value**
BMI (mean ± SD)	28.3±5.4	32.2 ± 3.6 **	0.00
- **Normal weight** 28 (16.5%) (No. & %)	17(10%)	11(6.5%)	0.12
- **Overweight** 21 (12.3%) (No. & %)	7(4.1%)	14 (8.2%) **	0.01
- **Obese** 16 (9.4%) (No. & %)	4 (2.4%)	12 (7%) **	0.00
Waist Circumference (WC) (mean ± SD)	94.1±9.4 cm	110.7±10.6 cm **	0.01
Hip Circumference (HC) (mean ± SD)	112.1±12.8 cm	115±11.9 cm	0.47
WHR (mean ± SD)	0.94 ± 0.8	1.04 ± 0.3	0.15

* P ≤ 0.05 Significant and ** P ≤ 0.01 Significant.

Table 4: M-8029- Vol. 30 No. 5 (2024)-Educational Administration Theory and Practice

	Elastography of Thyroid Nodules		
	Benign No. 61 (35.9%)	**Malignant No. 44 (25.9%)**	**P-value**
BMI (mean ± SD)	27.6±7.8	33.1±4.3**	0.00
- **Normal-weight** 32 (18.8%) (No. & %)	28 (16.4%)	4 (2.4%) **	0.01
- **Overweight** 29 (17.1%) (No. & %)	15 (8.9%)	14 (8.2%)	0.40
- **Obese** 44 (25.9%) (No. & %)	18 (10.6%)	26 (15.3%)*	0.05
Waist Circumference (WC) (mean ± SD)	88.6 ± 9.8cm	103.1±11.3cm**	0.01
Hip Circumference (HC) (mean ± SD)	110.1 ±6.4 cm	118 ± 5.2 cm	0.47
WHR (mean ± SD)	0.96 ± 0.6	1.01 ± 0.4	0.15

* P ≤ 0.05 Significant and ** P ≤ 0.01 Significant.

Discussion

Nodular thyroid disease is a common finding, with only 5% of the thyroid nodules being palpable, while it is diagnosed by thyroid ultrasonography (US) in 50% of the population. A minority of these nodules may cause health problems [11].

Many studies found that thyroid cancer is more frequent in females than males, which could be related to sex hormones, although some controversies were noted [12-13]. Females are usually undergoing routine clinical examination compared to males [14], which is the main cause that could explain this high frequency of thyroid nodules in the females. However, some researchers detected that gender (male) was a factor associated with carcinoma high risk [15-16]. The differences could be due to different lifestyles and each study's inclusion criteria. Results of this study showed that the number of malignant thyroid nodules was high in males (56.9% of total male patients) than in females. Regarding age, the younger age was frequently recorded in silent thyroid cancer [17]. This study recorded that 58.5% and 60% of male and female patients respectively were <45 years old.

Ultrasonography (US) is the basic diagnostic method to detect and examine thyroid nodules. The presence of certain characteristics such as; hypo-echogenicity, micro-calcifications, absence of halo, hypervascularity, irregular borders and taller than wider raise the malignancy suspicious, with the presence of more criteria in the same nodule leading to increased malignancy probability [18]. These characteristics are sensitive to detection without high specificity [19]. As thyroid nodule stiffness is a predictor of thyroid cancer. Elastography is used to assess the stiffness of nodules, which has been introduced into practice to enhance specificity in diagnosis and overcome the limitation of B-mode ultrasonography and Doppler assessment, this promising diagnosis of malignant nodules [6].

Results of this study showed that qualitative grades of elastography could be able to discrepancy benign thyroid nodules from malignant nodules; as higher elastography grades were recorded with malignant nodules, and low elastography grades with benign nodules. Moreover, all Strain's Ratio for malignant thyroid nodules is more than 2 and the cutoff value was > 2.3 which could distinguish a malignant thyroid nodule from a benign one with 93 % sensitivity, 81.4 % specificity and 92.4% accuracy. These results were compatible with many previous studies; Esfahanian et al. reported that ESGs were significantly higher in malignant nodules and 2 was the best cutoff value to differentiate between natural thyroid nodules (benign and malignant) with sensitivity & specificity (61% & 78%) respectively [20]. Although Asteria et al. reported the cut-off point was between 2-3, which is the best point of differentiation with sensitivity & specificity (94% & 81%) respectively [21]. While, Rago et al. detected that high elastography grades were highly suspected of malignancy with sensitivity and specificity (97% & 100%) respectively [21]. Gietka-Czernel et al. and Wang et al., used 5 scale scoring to differentiate thyroid nodules and revealed that elastography grades 4 & 5 were highly suspected of malignancy with sensitivity and specificity (86% & 97%) [23- 24].

Regarding adiposity, this study revealed that increased BMI was associated with a high risk of malignant nodules among both sexes, more evident in males. Previous studies detected stronger associations between BMI and thyroid malignancy among both sexes equally [25]. While some revealed positive associations among males [26], or among females only [27]. However, other studies revealed no association [28]. This association could be explained by multiple mechanisms, hyperinsulinemia, changes in leptin and adiponectin levels and chronic inflammation. The adipose tissue has also an important role in regulating levels of sex steroids, and estrogen synthesis which has been linked to mitogenic activity; leading to excess estrogen production, and causing estrogen/androgen imbalance in men and women [29].

Results of this study indicated that there was a statistically significant increase in BMI and WC in patients who had malignant thyroid nodules compared to those who had benign nodules. However, no statistical significance was detected at hip circumference (HC) and WHR, so abdominal obesity is associated with a higher risk of malignant thyroid nodules, which supports the hypothesized role of hyperinsulinemia in thyroid carcinogenesis. As, free fatty acids (FFA) are released from adipose tissue, especially abdominal visceral fat, induce hyperinsulinemia and insulin resistance, which could promote tumorigenesis and cell proliferation [30].

This study proved also; that BMI of more than 30 and WC of more than 105.6 cm & 95.7 cm for males and females respectively may be considered strong predictors of malignant thyroid nodules with (sensitivity of 84.3% and specificity of 82.1%) for BMI and (sensitivity 69.1% & specificity of 71%) & (sensitivity 72.1%, specificity 58.3%) for WC of males and females respectively. These results were in concordance with many studies as; Arduc et al., who suggested that high BMI and WC were associated with increased risk of thyroid cancer [31] and Kwon, in Korea, reported that the incidence of cancer thyroid increased significantly in subjects had large WC [32]. Also, study done by Kitahara et al. They detected there was a significant association between thyroid cancer risk and increased BMI & WC and no statistically significant association was detected with WHR. Although, WC and WHR are mainly reflecting visceral abdominal fat [33], HC reflects subcutaneous fat [9]. This finding could be explained that the waist adipose tissue could affect the thyroid malignant nodule directly rather than other body sites adipose tissue. This finding was consistent with Song et al., who revealed that WC is superior to BMI in assessing the thyroid cancer risk in the Chinese population [34]. Zhao et al., and de Siqueira et al., couldn't detect any significant difference between non-obese and obese patients [35-36]. So, BMI is not a perfect indicator of central adiposity as a WC which was more accurate and is also associated with other health problems. Thus, this study recommends using waist circumference, as it is an easily measured parameter.

Conclusions and Clinical Implication

The elastography ultrasonographic examination is an easy non-invasive accurate method to differentiate benign from malignant thyroid nodules, instead of FNAC. There is a high association between adiposity and thyroid nodules.

The authors state no conflict of interest.

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Author contribution

Safenaz Y. El Sherity (corresponding author): Ultrasound elastography assessment, Drafting the work and revising it critically for important. **Abbas MH**: Clinical assessment and Acquisition of the data. **Mohamed Metkees:** Analysis and interpretation of the data. **Karim G. Moustafa:** Clinical assessment and Acquisition of the data. **Shymaa A. Shalaby:** Design and Drafting the work. All authors shared in the work design and final approval before publishing this version.

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